Report for 2002CO46G: Occurrence and Fate of Emerging Organic Chemicals in Onsite Wastewater Systems and Implications on Water Quality Management in the Rocky Mountain Region

- Conference Proceedings:
    - Siegrist, Robert, 2002, Water Quality Protection Provided by Onsite Wastewater Systems, in Proceedings of the 13th Annual South Platte Forum, Colorado Water Resources Research Institute, Colorado State University, Fort Collins, Colorado, Information Series No. 94, p. 16-17.
- Other Publications:
    - DeJong, Kathy, Robert L. Siegrist, Abigail Wren, and Larry B. Barber, 2004, Occurrence of Emerging Organic Chemicals in Wastewater Effluents from Onsite Systems, accepted for platform presentation at the Tenth National Symposium on Individual and Small Community Sewage Systems, March 21-24, 2004, Sacramento, California, Am. Soc. of Agric. Engrs.
    - DeJong, K., 2004, "Occurrence of emerging organic chemicals in wastewater system effluents," presented at the 4th International Conference on Pharmaceuticals and Endocrine Disrupting Compounds in Water, Minneapolis, MN.

Report Follows

Problem and research objectives:

The purpose of this project was to collect field data on streams in the foothills and montane parts of Colorado in support of the State of Colorado's attempt to develop nutrient criteria in preparation for producing nutrient standards for Colorado waters. The state has identified high elevations as the highest priority, which explains the focus on streams of the mountains and foothills. The study was instituted to provide sufficient data on nutrients and potential ecological indicators of nutrient enrichment to establish thresholds of ecological change associated with nutrient enrichment. On this basis, thresholds for enrichments relevant to Colorado waters could be established for the state.

Methodology:

Nutrients of interest for this study include nitrogen and phosphorus, which are considered by the U.S. Environmental Protection Agency, the State of Colorado, and the research community to be the factors most likely to limit potential growth of autotrophs (algae and aquatic vascular plants" in aquatic ecosystems. Total phosphorus was analyzed, as were phosphorus fractions (soluble reactive phosphorus, total soluble phosphorus, particulate phosphorus). Dissolved inorganic nitrogen (nitrate, ammonia) was analyzed, but total nitrogen, which is considered to contain large amounts of unavailable forms of nitrogen, was not analyzed.

Response variables for the current study included biomass of attached algae (periphyton) measured as chlorophyll *a* per unit area, which is a conventional method for evaluating biomass of algae on illuminated surfaces. In addition, community composition of attached algae was considered a potential response variable, as was composition of the benthic fauna (bottom fauna) living in the streams. Chlorophyll data is cataloged, but the counting and identification of organisms, necessary for the community composition studies of periphyton and benthos, are still in progress. Response variables were sampled once (in fall).

Collections of all organisms at each site were made by standard methods, which involve taking multiple samples over the stream cross-section in order to compensate for spatial irregularities in the distribution of organisms. Sites were chosen so as to represent a range of elevations, and also to be located where an historical record was available for nutrient concentrations. Thus, the study did no rely entirely on nutrient samples taken at the time of sampling, but rather on a longer-term record that reflects more accurately the nutrient history of growth of the organisms at a particular site.

Approximately 75 sites were sampled at locations for which multi-year records were available for concentrations of total phosphorus (Figure 1). Most of these sites lacked adequate information on phosphorus fractions and on nitrogen fractions. Therefore, a subset of the sites (approximately 20) was analyzed with respect to these nutrient fractions.

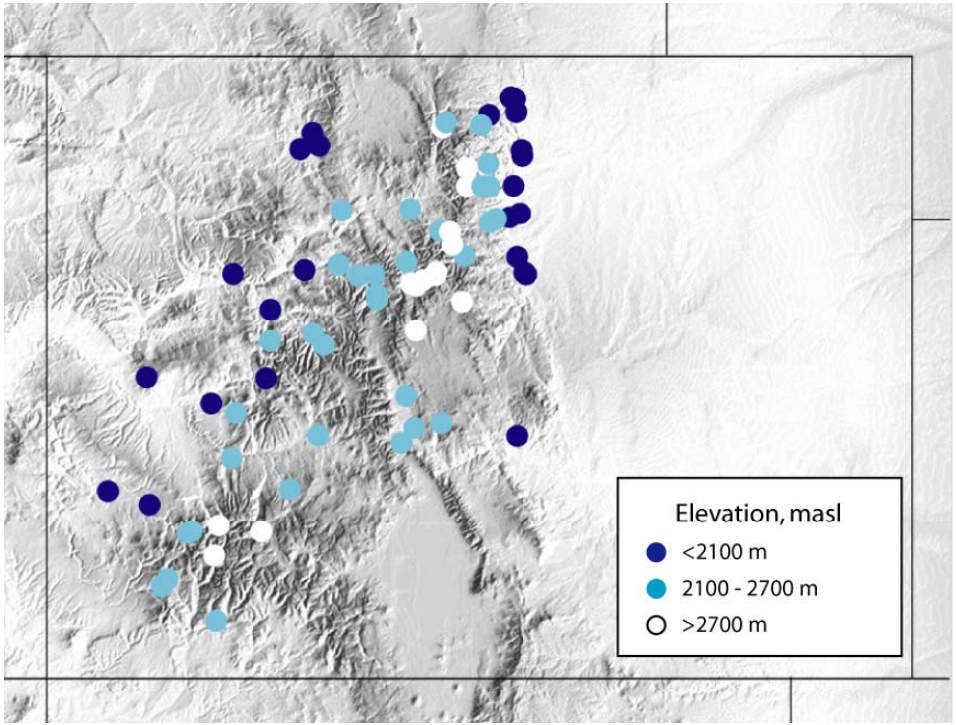

Figure 1. Map of sites sampled for this project.

Principal findings and significances

The premise at the beginning of the study was that growth of attached algae would depend in part on elevation. The sites were grouped for convenience into three elevation categories: high (greater than 2700 m), low (less than 2100 m), and intermediate (2100-2700 m).

Figure 2 shows the relationship between total phosphorus and chlorophyll *a* at the time of the fall sampling. Clearly, any sites from any elevation and for any annual mean phosphorus concentration can produce a high chlorophyll reading in fall. Sites with higher total P, however, show consistently high chlorophyll. Therefore, the main distinction between the sites is the range in chlorophyll concentrations that can be expected in fall: enriched sites (greater than 25µg/L total P) have consistently high chlorophyll, whereas unenriched sites or minimally enriched sites (below 25 µg/L) show a range of chlorophyll concentrations, including some very low amounts and some high amounts.

The relationship between chlorophyll *a* in the fall and the nitrogen and phosphorus fractions is shown in Figure 3. The general pattern is very similar to the pattern for total P. Basically, total P and the nutrient fractions give redundant information with respect to the response of biomass as represented by fall sampling. Therefore, total P can be used as the key nutrient factor.

The information on total phosphorus and chlorophyll suggest a threshold at about 25 µg/L total P separating a wide range of chlorophyll concentrations (below the threshold) from consistently very high concentrations above the threshold. This threshold could be used as the basis for nutrient criteria in Colorado. In terms of SRP (the soluble inorganic portion of phosphorus) the threshold falls at about 15 mg/L.

Additional sampling is underway through EPA support that will build on the observations made in this study. In addition, the studies of community composition may show that the threshold is verified or superceded by thresholds represented through community composition.

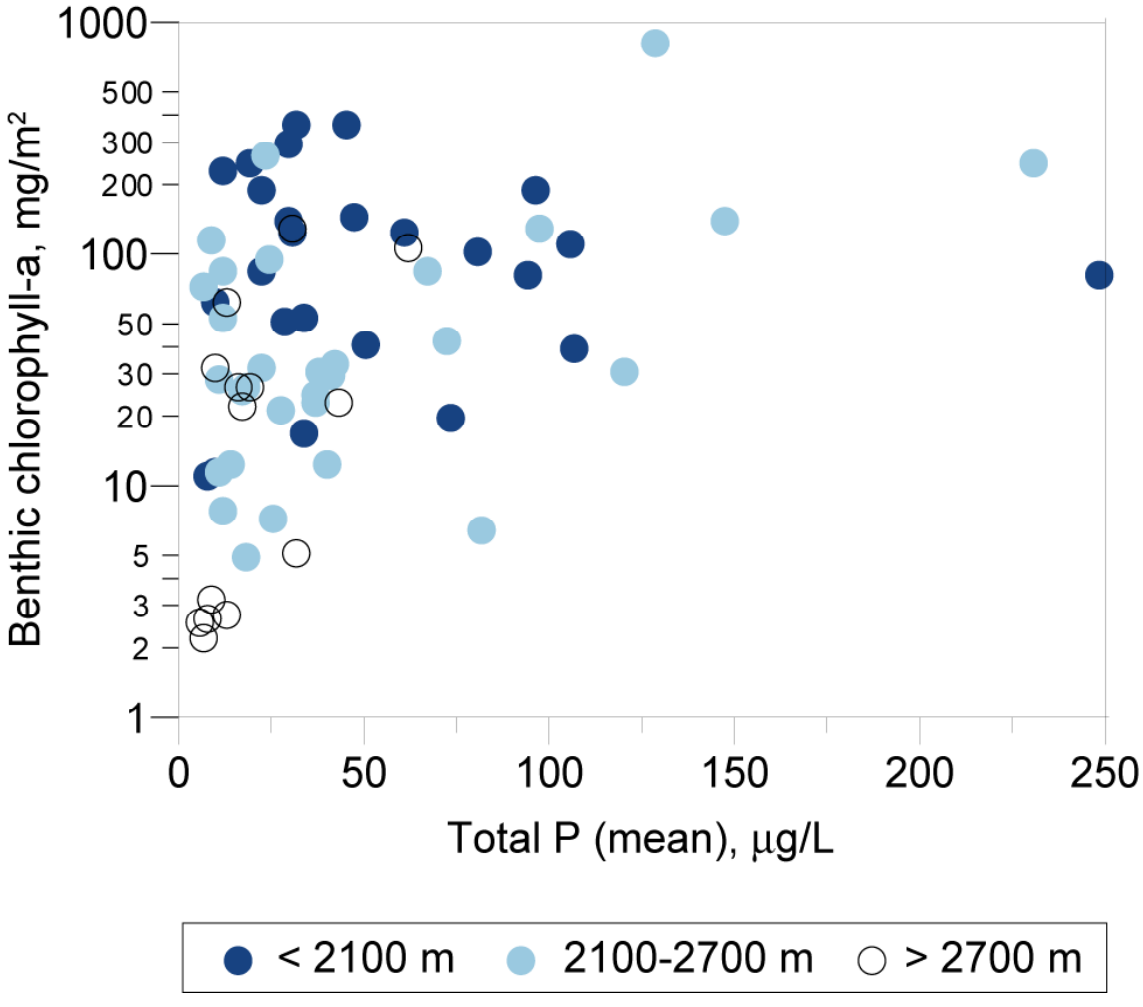

Figure 2. Benthic (periphyton) chlorophyll *a* in relation to mean total P for all dates. Open circles = high sites, Dark circles = low site, intermediate circles = intermediate sites.

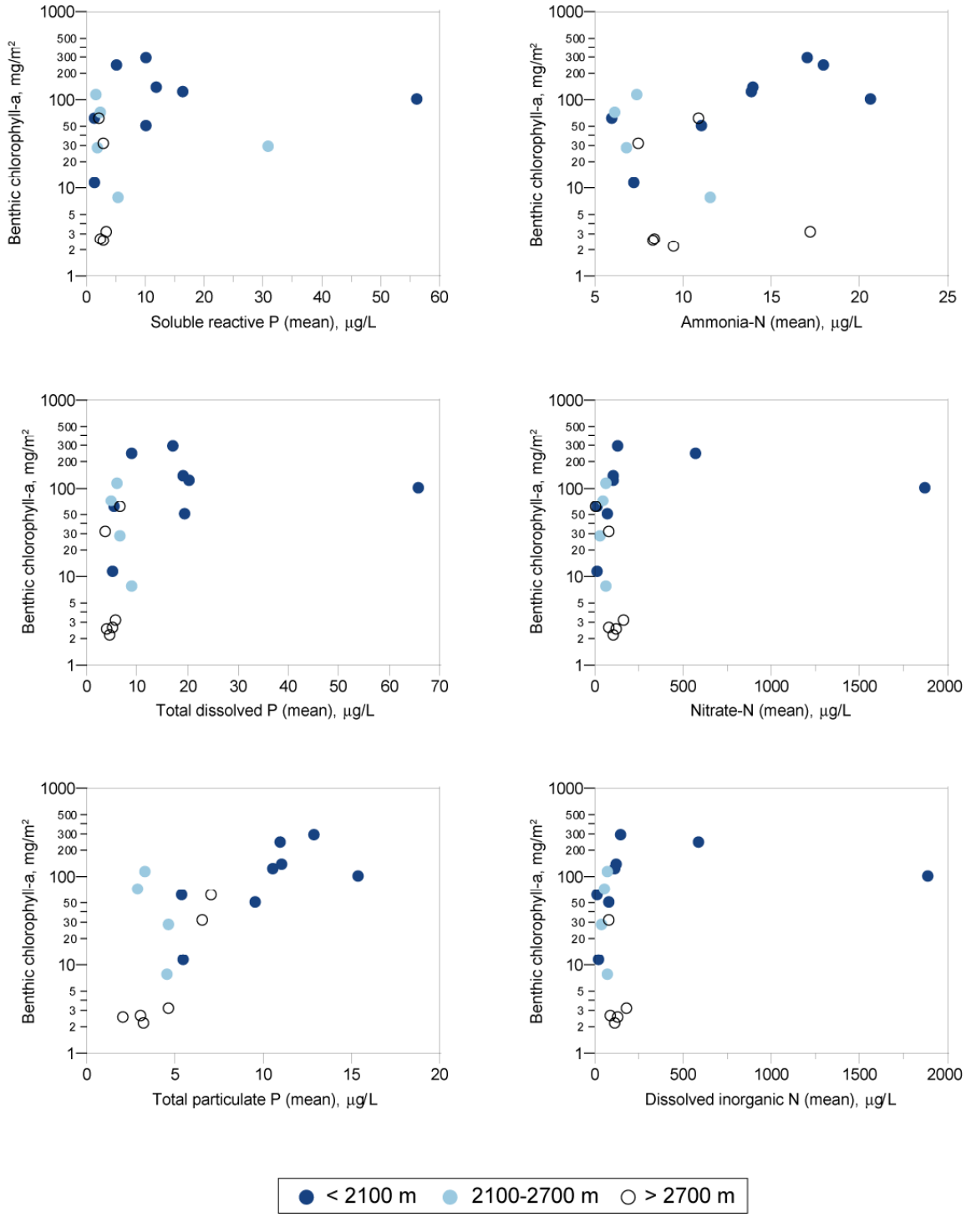

Figure 3. Benthic (periphyton) chlorophyll *a* in a relation to mean concentration of nutrients. Site coding same as for Figure 2.